WDNR Dispersion Modeling Guidelines

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1. Introduction

Dispersion modeling is a complex process requiring guidance in order to determine proper procedures. This document is intended to illustrate and explain various methodologies and guidelines concerning the atmospheric dispersion modeling performed by the Wisconsin Department of Natural Resources (WDNR). All modeling completed in the State of Wisconsin should be done in accordance with these procedures as well as guidance contained in the Guideline on Air Quality Models, EPA document 40CFR51, Appendix W.

A model is a mathematical simulation, designed to predict what can or will happen in real-world scenarios. Atmospheric dispersion modeling is useful in predicting the impact a particular facility will have with respect to a given pollutant. The major benefit of dispersion modeling is that it is an inexpensive way to determine the impact of a source. This information is vital in assessing a facility's compliance with respect to the National Ambient Air Quality Standards (NAAQS) as well as the various Hazardous Air Pollutant (HAP) standards, both federal and state mandated.

Dispersion modeling incorporates information about a facility, such as source parameters, facility layout information, and emission rates, along with meteorological data in order to predict concentrations of pollutants surrounding the facility. The point of highest impact is determined through the use of a receptor grid that is set up by the modeler. The pollutant concentration at the point of highest impact added to a pre-determined background is compared to the corresponding ambient air quality standard.

On November 9, 2005 USEPA promulgated a formal change to the Guideline on Air Quality Models, replacing ISCST3 (02035) with AERMOD (04300) as the recommended atmospheric dispersion model. The recommended use of AERMOD became effective on December 9, 2005.

2. Purpose of Modeling

Air quality dispersion modeling is performed to assess the impact of an air pollution source on the surrounding environment. The impact is quantified by predicting the concentration of the pollutant at ground level and then comparing that result to a reference level. The most commonly used reference for comparison is the NAAQS. These standards were developed by the United States Environmental Protection Agency (USEPA) to protect human health and welfare. Each standard is defined in terms of pollutant, averaging time, and level where health may be at risk (primary standard) or where materials may be damaged (secondary standard). The following table lists the current NAAQS:

Table 2.1
National Ambient Air Quality Standards
Concentrations in $\mu g/m^3$

		Primary	Secondary
Total Suspended Particulates (TSP)	24 hour	-	150.0
Particulate Matter < 10µ (PM_{10})	Annual	50.0	50.0
	24 hour	150.0	150.0
Sulfur Dioxide (SO_2)	Annual	80.0	-
	24 hour	365.0	-
	3 hour	-	1300.0
Nitrogen Oxide (NO_x)	Annual	100.0	100.0
Carbon Monoxide (CO)	8 hour	10000.0	10000.0
	1 hour	40000.0	40000.0
Lead (Pb)	Calendar Quarter	1.5	1.5

According to the regulations, the 24-hour PM_{10} standard is met when, "The expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$… is equal to or less than one." {sec. NR 404.04(8)(b)(2), Wis. Adm. Code} For a dispersion modeling analysis containing five years of data, this means the sixth highest value over the five years must be below the standard (including background).

However, Wisconsin also maintains a 24-hour TSP standard that uses the highest of the five second-highest concentrations from the dispersion model to demonstrate compliance. Statistically, the high second-high is the worst possible case of the sixth-highest over five years, and since the standards for PM_{10} and TSP are both 150.0 $\mu g/m^3$ one analysis for PM, using TSP emission rates and the highest second-highest concentrations, can be conducted and the same modeled impact used for both pollutants.

The other short-term (1, 3, 8, or 24 hour) standards are also met when the highest of the five second-highest modeled concentrations (plus background) are at or below the standard. The annual standards are met when the highest yearly impact plus background is at or below the standard.

In addition to the NAAQS, the State of Wisconsin has developed Ambient Air Standards (AAS) for hazardous air pollutants (HAPs) listed in Chapter NR 445 of the Wisconsin Administrative Code. To demonstrate compliance with the NR 445 compounds, the first-highest modeled impact is compared to the AAS. Air pollution sources in Wisconsin must attain and maintain all air quality standards.

Aside from dispersion modeling, a facility may demonstrate compliance with the air quality standards by directly sampling the air using an air quality monitor. Monitoring is the most direct method to measure the amount of pollutants in the air, but it has limitations. Monitoring is time consuming, labor intensive, costly, not predictive, and there are some difficulties associated with siting monitors.

Dispersion modeling, on the other hand, is not subject to the same limitations as monitoring. Atmospheric dispersion modeling can be used for pre-construction sources to determine the potential impact a facility would have. Modeling studies can be completed relatively quickly and cost-effectively.

While monitoring does have the advantage of providing direct measurements of the ambient air, the values are for a limited number of points. As meteorological conditions change, the monitor may or may not record the maximum impact. It is also important to note that monitoring results may provide data about a number of sources, not just the one in question. A monitor cannot easily differentiate whether a particular molecule of a pollutant comes from one source or another. Modeling, however, can be done to assess the impact from one source alone. In addition, while the model results are not direct measurements, they are based on model algorithms that have been verified against real-world data such as tracer gas studies or other ambient air monitoring.

The WDNR uses dispersion modeling to determine compliance with ambient air quality standards. Air permit writers and compliance inspectors make these determinations when conducting air construction and operation permit reviews, air compliance inspections, air complaint investigations, and air spill investigations. Dispersion modeling analyses are also used in the course of estimating risk, preparing environmental assessments and impact statements, developing air regulations and selecting site locations for ambient air monitors.

3. When to Model

3.1 General

WDNR modeling is used for a variety of purposes. Generally, sources must be modeled when they are applying for an air permit (construction, operation, or renewal) and must demonstrate the attainment of NAAQS, PSD Increments, or Wisconsin's NR445 and TSP standards. In addition, modeling is used to calculate ambient pollution concentrations in the establishment of a risk assessment or when the department receives a complaint. The model results are useful in verifying the source of the emissions as well as measuring the extent of the complaint.

3.2 Previous Modeling

In a memo dated October 7, 1998 (Refined Air Quality Dispersion Modeling Policy), it was established that prior air quality modeling results can be applied for operation permit applications when the facility has previously received an air quality permit which addresses all the same pollutants and sources in the current application, and the same physical stack parameters and emission limits will apply in the new operation permit. The memo also went on to state that if a new dispersion model is released by the USEPA that supersedes the model used in the prior analysis, the modeler and permit engineer should discuss the differences and ramifications of a new model with the company. For more information regarding the release of AERMOD and its applicability to specific permit types, see the AERMOD transition memo.

4. How to Model

The first step in modeling for a source is first to determine the type of model that is needed. There are two basic types of models used at the WDNR. The first type is classified as a screening model, while the second type is referred to as a refined model. The classification is based on the consideration of meteorological conditions and receptor placement. Screening models search through a limited number of meteorological conditions to determine which conditions will give the highest concentration. The calculations of concentrations are only made along the plume centerline. A refined model uses historical meteorological data to give a more realistic estimate of ground level concentrations. In addition, refined models allow for calculations of concentration in two dimensions.

Screening models allow for quick analysis of impacts from a single stationary source. Since the worst-case dispersion estimates are used in the concentration calculations, screening models are generally very conservative. With that in mind, if the screen model results are below regulatory standards, the need for the more time-consuming refined modeling may be eliminated. The WDNR currently uses SCREEN3.

Refined modeling uses meteorological data gathered at or near the specified location in order to calculate pollutant concentrations surrounding a source. The concentration calculations in a refined model are done on an hourly basis using a meteorological file supplied by the user.

The meteorological variables that should be defined in the refined model include wind speed and direction, atmospheric stability, and temperature, among others. The meteorological data must meet EPA guidelines for data capture, data quality, and the inclusion of upper air data. The WDNR keeps a preprocessed set of meteorological data accessible for use with refined modeling.

On November 9, 2005 USEPA promulgated a formal change to the Guideline on Air Quality Models, replacing ISCST3 (02035) with AERMOD (04300) as the recommended atmospheric dispersion model, to become effective on December 9, 2005. On December 7, 2005, WDNR issued an implementation memo addressing the use of AERMOD for each permit type for which modeling may be conducted.

Guidance concerning the use of refined models will follow the section regarding screening models.

4.1 Screening Modeling

4.1.1 Restrictions and Limitations

The first step in using a screening model is to determine whether it is appropriate for the current project. If any of the following statements are true, the SSMT should complete a refined modeling analysis.

1. The source is a PSD source (as described in Wis. Admin. Code Ch. NR405).

2. The source is not vented to the atmosphere through a stack (Ch. NR400.02 (147).

3. The source is located within 5000 meters (3 miles) of a PM, SO_2, NO_x, or CO nonattainment area (Currently, the only nonattainment areas in Wisconsin concern ozone). (Wis. Admin. Code Ch. NR401).

4. There are several stacks associated with this source that cannot be merged into a "representative stack" using the stack merging procedures outlined in WDNR SCREEN guidance.

5. The pollutant does not have an Ambient Air Standard (AAS) listed in Table A of the NR 445 requirements, Wisconsin Administrative Code.

6. The source is located in an area with significant topographical relief.

If a screening model is used and any of the following are true, the facility should be sent to the SSMT for refined modeling.

1. The pollutant is Pb, and the predicted 24-hour concentration (when calculated by the SCREEN model and multiplied by the 0.4 conversion factor) exceeds 1.3 $\mu g/m^3$.

2. The source is a new source located in a baseline PSD county for the pollutant considered, and the concentration as calculated by SCREEN is greater than the Significant Impact Level (SIL):

Table 4.1
PSD Significant Impact Levels
Concentrations in $\mu g/m^3$

Pollutant	Time Period	Concentration
PM10	24 hour Annual	5.0 1.0
SO2	3 hour 24 hour Annual	25.0 5.0 1.0
NOx	Annual	1.0

4.1.2 SCREEN Model Input Information

The following tasks should be completed before the SCREEN model can be run:

1. Compile a list of the parameters for each stack (if there is more than one stack for the pollutant, see number two below). The required parameters are:

   Stack Height (m)
   Normal Stack Gas Exit Velocity (m/s or ACFM)
   Stack Inside Diameter (m)
   Normal Stack Gas Exit Temperature (K)
   Pollutants Emission Rate (g/s)

2. If the facility has more than one stack for a particular pollutant, calculate a single representative stack using the stack merging procedures. If the stacks cannot be merged, each stack should be modeled separately and the maximum concentrations summed together for comparison to the appropriate standards. If the total exceeds any standard, the project should be referred to the SSMT.

3. Determine if the source is in a RURAL or URBAN area, as defined by USEPA. The only URBAN location in Wisconsin under EPA guidelines is the central city of Milwaukee.

4. Building heights in the vicinity of the facility need to be examined to determine if the plume is affected by downwash. Building heights must be considered in relation to the building's width to determine the most significant building. To determine the controlling building, compute the effective building index (H_e) for each structure within a horizontal distance equivalent to five times the height of the stack.

   $$H_e = H_b + 1.5(L_b)$$

   Where: H_e is the effective building index
   H_b is the actual building height
   L_b is the lesser of the building height or maximum width (usually the diagonal)

   The structure with the largest H_e is considered the controlling building. Determine the building height, the minimum building width, and the maximum building width for the controlling building. Enter the controlling building height and lateral dimensions into SCREEN3.

5. The receptors should extend beyond the point of maximum impact, so when using the automated distance array, the minimum distance should be 50 meters and the maximum distance 5000 meters.

4.1.3 Output Analysis

The maximum concentration is found in the output file created by the SCREEN model. This concentration is the maximum in a one-hour period, so it must be converted to the proper averaging period. Use the conversion factors in the following chart (as determined by USEPA) to convert to the time period of interest:

Table 4.3
SCREEN Output Conversion Factors

To Convert to	Multiply Concentration by
3 hour	0.9
8 hour	0.7
24 hour	0.4
Annual	0.08

If lead (Pb) is being modeled, compute the 24-hour concentration using the conversion factor above. If the predicted concentration is less than or equal to 1.3 $\mu g/m^3$, no further modeling for Pb is required. If the value is higher than this, the modeling for all pollutants should be referred to the SSMT.

The total concentration is calculated by adding the screening model output to the appropriate background concentration. This calculation is not performed for HAPs, as currently there are no regional background values for HAPs, so the modeled concentration is directly compared to the standards

4.2 Refined Modeling
The current model approved for regulatory use is AERMOD (04300). AERMOD handles many sources with hundreds of receptors, uses real-world preprocessed meteorological data , and accounts for building effects and terrain.

4.2.1 Required Information
A variety of information is needed in order to perform air quality dispersion modeling with AERMOD (04300). The first step a WDNR permit writer should complete when desiring modeling is to fill out a modeling request form, which can be accessed through the Air Permit Software (APS). The form, when completed, provides the modeler with all of the necessary information to complete the modeling in a timely fashion. Once the modeler has received the modeling request form and specified necessary materials, a completeness check will be done. Within three business days, the modeler will examine the request to let the permit reviewer know if all the necessary information has been provided. In addition, the modeler will attempt to provide an approximate date of project completion.

The following sections identify information that is necessary for setting up and running a refined modeling analysis using AERMOD. The information is mostly applicable to permit writers at WDNR, but is presented here so that external customers understand all the information necessary for a modeling analysis.

If an applicant is performing their own modeling, they may wish to consult with WDNR prior to submittal. The consultation can include meteorological data selection and any other concerns the applicant may have. The consultation can occur via phone call or email to the appropriate regional contact, or the applicant may wish to submit a modeling protocol for WDNR review.

4.2.2 Model Input Information
4.2.2.1 General
4.2.2.1.1 Permit Reviewer Information
Name of Reviewer, Date of Request Submittal, Date of Project Completion, Priority of Request

4.2.2.1.2 Company Information
Name, FID Number, Permit Number, Facility Address, City, County, Permit Contact (Name and Phone Number)

4.2.2.2 Dispersion Model and Options
4.2.2.2.1 Model Selection
Most dispersion modeling projects in the State of Wisconsin should be completed using AERMOD, according to WDNR guidance. The most recent version of AERMOD should be used at all times.

4.2.2.2.2 Options
The regulatory default options should be selected in the input file.

4.2.2.2.3 Dispersion Coefficients

Most locations in Wisconsin are defined as "Rural" using the Auer Land Use Method. In 2004, the modeling team conducted a land use analysis in order to identify urban locations within the state. The only "Urban" location found in Wisconsin is found in the Milwaukee area. A memo was written detailing the area and a map was made. For urban locations, please use a population of 600,000 and a roughness length of 0.6 meters.

4.2.2.3 Source Information

The following information should be provided within the modeling request:

4.2.2.3.1 Stack Parameters for All Stacks (combined parameters should not be used in the refined analysis)

- Stack height (feet or meters) as measured from ground
- Stack inside diameter (feet or meters) with an indication of whether the stack exit opening is circular or rectangular
- Normal or average stack exit flow rate (used to calculate exit velocity) with an indication of the stack orientation and obstruction status. Any stack that has a vertical orientation and has unobstructed flow (or has a rainhat that opens when there is pollutant discharge) may have exit velocity calculated and included in the modeling input files. A stack that either deviates from the vertical by more than 10 degrees and/or is obstructed will be assigned a default exit velocity of 0.10 meters per second.
- Normal or average stack gas exit temperature
- Maximum hourly emission rate in pounds per hour for all pollutants requiring modeling

4.2.2.3.2 Plot plan identifying all locations of all stacks, all buildings (with heights and elevation differences clearly identified), true north, location of facility with respect to nearby roads or other identifying landmarks, fenceline (if applicable), and property line. Stack and building locations will be measured in Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83) with true north along the y-axis. Buildings at the facility, as well as neighboring buildings that are not part of the facility should be examined to determine if they affect the source. A building influences a stack if the distance from the nearest building edge to the stack is less than five times the building height. Or, all buildings at the facility and any neighboring building that may be thought to have an impact can be measured and input to the BPIPPRM (Building Profile Input Program for PRiMe). The output of BPIPPRM will include all buildings that cause downwash.

If modeling has been completed previously in another datum (i.e. NAD27), the applicant may continue to use that datum as long as WDNR is notified. The facility should be aware that WDNR terrain data is in NAD83, so the applicant should provide all input files and be sure to verify (using real world data) that the terrain elevations are accurate.

4.2.2.3.3 Operating Scenarios

Examples of varying operating scenarios that may be included in the modeling request include hours of operation restrictions, stacks that do not operate simultaneously, stacks operating at varying loads, varying seasonal emission rates, or any other operational procedure varying from 100% load and 100% operation at all times. These scenarios do not have to be included in the request if the facility is not willing to have the scenarios placed in their permit, but the information may help solve modeled exceedances.

4.2.2.4 Increment Sources

Facilities located in a county that has its PSD baseline set may need to have an increment analysis performed. Sources at a facility constructed or modified after the baseline date are subject to an increment analysis. In addition, sources (at other facilities) nearby the facility that have been constructed or modified after the baseline date may need to be included in an increment analysis. In general, sources within two kilometers of the facility should be included in the analysis, but any increment-consuming source that has an impact within the area of significant concentration gradient should be included in the analysis. The ambient air standards for increment analyses are included in Table 4.4. More information regarding increment analyses can be found in the PSD section of this document.

4.2.2.5 Receptor Information

Receptors should be placed where impact will be the greatest. The selection of receptor sites should be done on a case-by-case basis, taking into account the topography, climatology, proximity of neighborhoods, etc., but the resolution of the receptor grid in the area of maximum impact should be 25 meters.

4.2.2.5.1 Ambient Air

Receptors should be placed in locations such that they are measuring "ambient air" as defined by USEPA. The definition states, "the air everywhere outside of contiguous plant property to which public access is precluded by a fence or other effective physical barrier should be considered in locating receptors. Specifically, for stationary source modeling, receptors should be placed anywhere outside inaccessible plant property." (taken from a USEPA letter from "Regional Meteorologists" to Joseph Tikvart regarding ambient air). The Wisconsin SSMT uses the following in defining a fence:

A fence shall be defined as any permanent, effective, physical barrier that impedes public access to a facility at all times. For refined modeling purposes, the air everywhere outside this barrier should be considered when locating receptors. For example, receptors should be included over unfenced plant property, over bodies of water, over roadways, and over property owned by other sources. Property that is not completely enclosed by a fence is considered ambient air.

It should be noted that receptor placement in the case of HAP modeling does not need to follow the fenceline guidelines, as NR445 mandates that all modeling of regulated toxics begin at the property line.

4.2.2.5.2 Terrain

AERMOD is specifically designed to handle the inclusion of terrain in modeling. Therefore, terrain should be used in analyses done for facilities in Wisconsin. If there are specific cases where the use of terrain is suspect, the cases should be brought to the attention of SSMT and a decision will be made regarding its use on a case-by-case basis.

Terrain data should be processed using AERMAP according to the procedures described in the AERMAP user's guide.

4.2.2.6 Meteorological Data

In the AERMOD Implementation Guide, USEPA addresses the selection of surface characteristics for facilities. The guide stresses the importance of using surface characteristics specific to the instrumentation location, not the source(s) site. WDNR has processed many sets of NWS meteorological data for use in AERMOD. The AERMOD implementation guide suggests that if the "nearest NWS meteorological site's surface characteristics are determined to NOT be representative of the application site, it may be possible that another nearby NWS site may be representative of both weather parameters and surface characteristics." WDNR supports this position and suggests the use of the preprocessed meteorological data provided. If a situation arises where site-specific meteorological data may be warranted, the applicant should contact WDNR before proceeding in order to settle on a protocol for assembling the meteorological data prior to any modeling submittals. When using the preprocessed NWS meteorological data, WDNR requires running the five consecutive meteorological data years for each pollutant applicable. The WDNR preprocessed meteorological data is available from the Stationary Source Modeling website. If an applicant is performing modeling and is unsure which meteorological data set to use, the applicant should contact the appropriate WDNR regional contact.

For an in-depth guide to the use of AERMOD (04300), please see the *User's Guide for the AMS/EPA Regulatory Model AERMOD*.

4.3 Types of Dispersion Modeling Analyses

The number and types of sources that should be included in modeling vary according to the type of project. The following descriptions of project types are intended to assist in understanding how the modeling analysis is done, as well as aid the permit writer in preparing the modeling request properly.

4.3.1 Prevention of Significant Deterioration (PSD) Sources

The PSD regulations were devised to be more restrictive than the federal AAQS in order to permit "economic growth in a manner consistent with the preservation of existing clean air resources…in areas such as national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value" (Clean Air Act, 1990). There are two classes of PSD areas in Wisconsin for PM_{10}, SO_2, and NO_x (Ch. NR 404.05). The two categories are designated Class I and Class II.

Congress specified the initial classification of lands for PSD purposes in the Clean Air Act Amendments of 1977. Class I lands are those where the existing good air quality is determined to be of national importance. Class I areas may not be reclassified. These mandatory Class I areas include all international parks, national memorial parks larger than 5,000 acres, and national parks larger than 6,000 acres that were in existence when the Amendments were passed. All other areas to which the PSD provisions apply were classified as Class II.

Class I areas are the most stringently regulated as these are generally locations that have remained untouched by industry. Of the 220 federal Class I areas that exist, there is currently only one Class I area in the State of Wisconsin. This is the Rainbow Lake Class I Area. Rainbow Lake and Bradwell Bay Wildlife Area in Florida are unique among the PSD Class I areas. Both are specified as areas where visibility is not recommended as important value. Consequently, air quality modeling that considers Rainbow Lake does not have to include an air quality visibility analysis.

In addition, any new PSD source that locates within 200 kilometers of a Class I Area, must notify the applicable Federal Land Manager (FLM). For information regarding a facility's proximity to Class I Areas, please click on the following memo and map for more information.

New sources that exceed major source thresholds in attainment counties require a PSD permit review (Ch. NR405.02 (22).

Before PSD application submittal to the Department, the applicant should provide a modeling protocol, outlining any assumptions and data used in the modeling analysis. Questions regarding proper protocol submittal should be directed to the Stationary Source Modeling Team.

If the facility in question is setting the baseline for a pollutant, then that facility should undergo a significance analysis. In this analysis, the first highest concentration for each time period specified is compared to the Significant Impact Level (SIL). If the facility impact in this analysis is less than the SIL, the facility does not have to undergo an increment analysis or NAAQS analysis. If however, the facility is located in a county where the baseline has already been set, an SIL analysis is not necessary because the facility will be analyzed against any applicable increment and NAAQS. Numerous counties in the state have had a PM_{10}, SO_2, or NO_x baseline set. The PSD baseline counties and the corresponding maps by pollutant (PM10, SO2, and NOx) help determine where additional analyses are necessary.

If the facility does not pass the SIL, or if the SIL is not necessary because the baseline has already been set for that particular pollutant in the county where the facility is located, then an increment analysis should be performed. The increment analysis should consider all sources at the facility that contribute to the PSD increment, which includes all new sources, as well as any sources on site that were installed after the PSD baseline was set. Additional increment consuming sources that have an impact within the area of significant concentration gradient should also be included. In general, this distance is at least 2 kilometers from the source requesting a permit, but may vary due to the nature of the sources in the area. For example, a small facility 2 kilometers away may have less of an impact than a large facility 2 kilometers away.

The modeled concentration for each applicable baseline pollutant is compared to the increment consumption value for the type of PSD area involved in the analysis. Background concentrations are not added to the modeled concentration when comparing to the increment. The PSD increments for Class I and Class II areas, as well as the significant impact levels are included here:

Table 4.4
PSD Class I and Class II Increments

Pollutant	Averaging Time	Class I Increment	Class II Increment	Class I SIL	Class II SIL
		(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
Sulfur Dioxide (SO_2)	3 hour	25	512	-	25
	24 hour	5	91	1	5
	Annual	2	20	-	1
Particulate Matter (PM_{10})	24 hour	8	30	1	5
	Annual	4	17	-	1
Nitrogen Oxide (NO_x)	Annual	2.5	25	-	1
	24 hour	-	-	1	-

The total impact of the new or modified sources along with any additional increment consuming sources may not consume more than the increment in order to be approvable.

Another portion of the PSD review is the NAAQS analysis. Any proposed facility that has an impact above the SIL as defined above, or a source that is located in a previously baselined county must have an NAAQS analysis performed for that pollutant. This analysis will contain all the emission sources at the facility, as well as all emission sources at all nearby facilities.

If the new and modified equipment qualify for the SIL analysis and their impact is below the significant impact level, then the modeling analysis is complete unless previous facility-wide modeling or an operation permit exists. In this case, the new and modified sources will be included in the facility-wide modeling to assess the overall air quality impact regardless of the modeled significance.

If the facility applying for a PSD permit already has an operation permit, with compliance plan schedule, please refer to the "Special Cases" section for information.

4.3.2 Minor New Source Review (NSR) Baseline County

Under current WDNR policy, minor new source reviews in a baseline county will be analyzed for increment consumption. In these types of analyses, an increment and NAAQS analysis are performed. All increment consuming sources that have an impact within the area of significant concentration gradient are modeled together to insure attainment of the increments. In addition, all previously modeled or permitted sources at the facility are modeled against the NAAQS.

4.3.3 Minor NSR Non-Baseline County

A NAAQS analysis will be performed for any minor new source permits, including all previously modeled or permitted sources at the facility.

4.3.4 Operation Permits

The entire facility will be modeled in an operation permit. The current USEPA regulatory model will be used in this analysis. If the facility is located in a baseline county and has increment consuming sources that were not previously modeled, they will be modeled against the increment.

4.3.5 Operation Permit Renewals

The entire facility will be modeled in an operation permit renewal. In addition, PM sources that were not previously modeled will be included in the renewal analysis. If the facility up for renewal has no changes from the operation permit (emissions, stack parameters, stack locations, building locations), then prior air quality modeling can be applied. If modeling is still requested, the current USEPA regulatory model will be used in an operation permit renewal analysis. Please see the AERMOD transition memo for specific information regarding renewals.

4.3.6 Nonattainment Area Analyses

Currently the only nonattainment areas in the state are classified for ozone, which is not modeled by the WDNR SSMT. Should a nonattainment area be added for Wisconsin, instructions regarding modeling in or near nonattainment areas would be added to this document.

4.4 Special Cases

4.4.1 Fugitive Dusts

To be consistent with federal PSD guidance, all PSD projects submitted to the department should include fugitive dust modeling. This includes modeling for unpaved roads, coal piles, and other emissions that are not vented, but rather dispersed naturally. The process fugitive emissions should be parameterized as either volume or area sources, according to how the emissions are generated. For example, if the emissions are from the surface of a clarifying pond then an area source should be used. If the emissions are from indoor processes that are exhausted to the atmosphere through open windows and doors, then a volume source (or several volume sources) should be used. If the building has many powered roof vents that keep the air flowing into the building at ground level, then each vent should be modeled as a point source if the stack parameters are known or as an elevated area source if the vent parameters are unknown.

For roadway dust generated by vehicle traffic, a series of volume sources separated according to USEPA guidance for line sources should be modeled. Generally, one-meter source heights are used, with the initial vertical term representative of the size of the vehicle tire. For fugitive dust emissions from storage piles, either volume sources or elevated area sources with initial vertical terms can be used, depending on the configuration of the piles. In either case, the source height should be set to one-half the normal height of the pile. The wind-generated emissions from the pile can also be modified in the modeling run using the STAR flag on the EMISFACT keyword (refer to the AERMOD User's Guide for further details).

4.4.2 Fugitive Emissions

There are fugitive emissions that should be modeled for all types of analyses. These include emissions that are created within a facility building that are not vented directly to a stack and small emission units that are written together in the permit. Also, if the emissions are reasonably ducted to and emitted from an opening, then they are not fugitive. Examples include natural gas heaters with roof vents, foundry furnaces, and dip tanks vented to general building ventilation. These types of sources should be submitted in the modeling request.

4.4.3 Toxic Modeling

Hazardous air pollutants (HAPs) are regulated both for their short term (acute) and long term (chronic) effects. People exposed to toxic air pollutants at sufficient concentrations and durations may have an increased chance of getting cancer or experiencing other serious health effects. These health effects can include damage to the immune system, or neurological, reproductive (e.g., reduced fertility), developmental, respiratory and other health problems. Wisconsin regulates several hundred toxic air pollutants under chapter NR 445, Wis. Adm. Code (PDF, exit DNR). WDNR has compiled a table of the various regulated compounds, sortable by name and/or Chemical Abstracts Service (CAS) number.

There are a number of ways for a facility with toxic emissions to show compliance with NR445. One way to show NR445 compliance is to use the table threshold values. Columns (c), (d), (e), and (f) are emission thresholds for different stack height categories and are expressed in pounds per time period. The thresholds act as triggers to determine what a facility would need to do in order to demonstrate compliance. A source with non-exempt, potential emissions equal to or less than the threshold values for the respective stack heights does not need to do anything further under the chapter. A source with non-exempt potential emissions greater than the threshold values for the respective stack height may need to explore modeling as a means of compliance.

Modeling for HAPs is done using the same methodology as for criteria pollutants, with the only exceptions being that the ambient air (for a HAP analysis) begins at the property line, and the first highest modeled impact is compared to the appropriate standard

4.4.3.1 Cancer Causing HAPs

Many compounds regulated by the WDNR are thought to cause cancer in humans. These compounds do not have an Ambient Air Standard (AAS). Rather, they are listed as a Best Available Control Technology (BACT) or Lowest Achievable Emission Rate (LAER) compound. Cancer causing compounds can be modeled in order to determine their inhalation risk. All non-exempt emissions should be included in HAP modeling. The modeled concentration is multiplied by the risk factor found in the table. If the risk is calculated at one in a million or less, the facility has demonstrated compliance with NR445. If the facility cannot meet threshold emission levels, and cannot demonstrate compliance through modeling (at the one in a million level), they will need to explore other options such as a multi-pollutant inhalation risk analysis, or requesting a toxic BACT or LAER analysis.

4.4.3.2 Non-Cancer Causing HAPs

Many of the compounds regulated by WDNR are not thought to cause cancer. These types of HAPs will have an AAS found in column (g). If a facility needs to model a non-cancer causing HAP for a compliance demonstration, the modeled concentration (first highest value for corresponding time period) can be compared to the AAS.

4.4.4 Facilities with Compliance Plans

Occasionally, a facility with an operation permit issued with a schedule to come into compliance, will want to obtain a PSD permit for construction of a new source. In order for the modelers to assess the facility at the time of the application, it may be necessary for the facility to supply updated information as to the status of the changes made to come into compliance. As changes are made to the facility and information is subsequently supplied to the SSMT, the facility can be modeled to take the changes into account.

4.4.5 Emergency Generators

Any emergency generators at a facility that emit at levels above permit inclusion thresholds should be included in a permit review/modeling request. Often when these units are modeled assuming 24 hours per day operation, they contribute heavily to a predicted exceedance. In order to increase the efficiency of permit issuance, emergency generators can be reviewed according to their typical operating scenario (i.e. when tested). The normal hourly restrictions from these tests can be placed into the permit. In the event of an outage or true emergency event, in which the facility would need to operate the generator for a longer period of time, the facility would need to notify the WDNR (Ch. NR436, Wis. Adm. Code).

4.4.6 Flares

In accordance with EPA policy, WDNR models flares using the following methodology:
Height of stack = Height of stack
Temperature = 1273K
Exit Velocity = 20 m/s
Diameter = $9.88e\text{-}4(Q_H)^{0.5}$

Where $Q_H = 0.45(H)$

And H = total heat release rate in cal/sec

4.4.7 Flagpole Receptors

Within the dispersion model, receptors can be assumed to be at ground level, or above the terrain as if set on a pole. These are known as flagpole receptors. USEPA has indicated that flagpole receptors are not acceptable for use in regulatory (permit) applications. Flagpole receptors should only be used on a case-by-case basis for model evaluation purposes. It is both the convention and the default mode to assume a height of zero meters above ground to represent ambient air. This convention should be followed for regulatory modeling purposes.

4.5 Model Output Analysis
When using NWS preprocessed meteorological data, refined modeling analyses should be completed using all five years of sequential meteorological data. All concentrations calculated by the model are based on a one-hour value averaged over the requisite time period. The modeled concentrations are then compared to the appropriate standard. The monthly, quarterly, and annual standards, PSD increments, and all AAS may never be exceeded, so the first highest value is examined for making the comparison. The short-term NAAQS standards (1 hour, 3 hour, 8 hour, and 24 hour) may be exceeded once per calendar year, so modeled results are given as the highest of the five second-highest values from the five years of meteorological data (i.e. one value per year).

4.5.1 NO_2 Output Analysis
The USEPA Guideline on Air Quality Models suggests a multi-tiered screening approach for estimating an annual NO_2 value. This approach uses an assumption that only a portion of the NO_x is converted to NO_2.

Tier 1 involves using the appropriate Gaussian model to estimate the maximum annual average concentration. A total conversion of NO_x to NO_2 assumed. If the concentration exceeds the NAAQS and/or PSD increments, then the modeler is to proceed to the second tier. In March of 2002, the EPA also gave permission for the Ambient Ratio Method to be applied during Significant Impact Level analyses.

Tier 2 consists of multiplying the Tier 1 estimate by an empirically derived NO_2 / NO_x value of 0.75. This value is the national default ratio of NO_2 conversion from NO_x.
If Tier 2 is applied and the facility is found to pass the NO_2 standard, no further analysis is necessary.

4.5.2 Background Concentrations
Before the model output can be compared to the ambient standard, a regional background concentration must be added. The intent of the background value is to assess the total impact on human health by examining all sources of air contaminants, including those sources that are not modeled, but exist within the region. Examples of sources included in the background concentration are other point sources, mobile sources, other fugitive sources, and fugitive dust from a number of sources including but not limited to coal piles and roadways. Background concentrations are derived from several years of actual monitoring data collected at sites around the state. In order to ensure that the numbers are as accurate as possible, the monitors are situated such that they are not directly affected by a particular source. The background values are added to the modeled concentration in order to determine the maximum impact. The background values are updated on a periodic basis and are available on the WDNR website, or from any SSMT member. Background concentrations are not used in an increment analysis.

4.5.3 Reducing Impact
Once the appropriate background value has been added to the modeled concentration, the total is compared to the NAAQS standards. If the maximum impact is greater than the applicable NAAQS, then the permit applicant may want to explore opportunities to reduce the impact. Modelers can often help with some suggestions for reducing the impact. A list of some solutions is included here:

1. The most logical place (from a modeling standpoint) to begin is with a reduction in the emission rate. The Gaussian Dispersion Equation upon which dispersion models are based, is:

$$C\,(x,y,z;H) = \frac{QVD}{2\pi u_s \sigma_y \sigma_z} \exp[-0.5(y/\sigma y)^2]$$

The concentration, which is given here as C, is directly proportional to the emission rate, Q. The relationship between the two guarantees that the most direct way to reduce the impact of a source is to reduce the emissions, so a logical place for permit reviewer to start would be to double check emission estimates. Or, perhaps there is stack test data that is better than emission factors. In addition, there may by opportunities for emission reductions that the permit reviewer could explore.

2. The second recommendation is to double check stack parameters. Also double check for a fence. In many cases, the fenceline has not been noted on the plot plan and so is not taken into account in the modeling. If a plot showing the position of the fence can be provided, this information can be included in the modeling.

3. The next recommendation is to thoroughly review the plot plan and accurately label all building tier heights, both at the eave and the peak. AERMOD is sensitive to building effects, so providing building heights as the structure was actually built helps insure the accuracy of the analysis.

4. Another way to reduce concentration is to alter the characteristics of the exit gas itself. A way to go about this is to remove rain-hats and/or turn horizontal discharges upward. This is because vertical, unobstructed stacks will give the best dispersion.

5. If these simple recommendations do not work, another way to mitigate an exceedance is by raising the stack. Increasing the stack height physically moves the effluent further from the ground. It also reduces the downwash effects of nearby buildings. The amount of height increase required to reduce concentration depends on a number of factors including stacks gas exit velocity and temperature, nearby building heights, and the physical layout of the facility. No standard ratio can be used, which means that each new scenario must be remodeled.

6. Occasionally, facilities disagree with the use of maximum emissions and normal flow in modeling. If a facility would like a modeler to consider the maximum flow and temperature along with the maximum emissions, it will be necessary for the facility and the permit engineer to provide the corresponding information for varying loads, so that a load analysis can be performed. Standard modeling practices avoid this by using the normal flow and temperature along with the maximum emissions, thus encompassing all possible operating scenarios. Consult a modeling team member for more information on the requirements, as they can vary slightly based on the process in question.

5. Staff Contacts

For any questions related to modeling, please contact one of the WDNR modelers listed below. The contacts are assigned to regions, so for questions specific to a particular region, please contact the appropriate person.

Northeast - John Roth (SSMT leader) – 608 267-0803
Northern – Jeff Sims – 608 266-0151
West Central – Jeff Sims – 608 266-0151
Southeast – Gail Good – 608 267-0803
(or Dan Hellenberg – 414 263-8562)
South Central – Gail Good – 608 267-0803

Dan Meinen (Modeling LTE) 608 266-6910